Physicochemical Properties of Biscuits produced from Wheat, Tulsi and Lemon Grass flour blends

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ABSTRACT

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| **Aims: To determine the** physico-chemical properties of biscuit produced from wheat, Tulsi and Lemon grass flour blends.  **Study Design:** The data was statistically analyzed by using complete randomized design (CRD) with ten treatments; the significance of study was tested at 5 per cent level  **Place and duration of Study:** The various equipment used in the present study during 2022-23 was taken from Food Analysis and Instrumentation Laboratory, Department of Processing & Food Engineering, VIAET, SHUATS, and Food Analysis and Research Laboratory, Centre of Food Technology (CFT), University of Allahabad, Prayagraj are given below.  **Methodology:** A lab experiment was conducted during 2022-23, comprising (T1) Whole wheat flour (100 %), (T2) Whole wheat flour (97.50 %) + tulsi leave powder (2.50 %), (T3) Whole wheat flour (97.50 %) + lemongrass leave powder (2.50 %), (T4) Whole wheat flour (95.00 %) + tulsi leave powder (2.50 %) + lemongrass leaves powder (2.50 %), (T5) Whole wheat flour (95.00%) + tulsi leave powder (5.00 %), (T6) Whole wheat flour (95.00%) + lemongrass leave powder (5.00 %), (T7) Whole wheat flour (90.00 %) + tulsi leave powder (5.00 %) + lemongrass leaves powder (5.00 %), (T8) Whole wheat flour (92.50 %) + tulsi leave powder (7.50 %), (T9) Whole wheat flour (92.50 %) + with lemongrass leaves powder (7.50 %) and (T10) Whole wheat flour (85.00 %) + tulsi leave powder (7.50 %) + withlemongrass leaves powder (7.50 %), was laid in completely randomized design replicated thrice.  **Results:** The treatment (T10) Whole wheat flour (85.00%) + tulsi leaves powder (7.50%) + with lemongrass leaves powder (7.50%) provided the significant and maximum protein (7.82 g/100g), fat (11.81 g/100g), ash (3.33 g/100g), and crude fibre (4.95 g/100g). Moreover, carbohydrate (73.65 g/100g) was found in treatment (T1) Whole wheat flour (100%) during analysis. In the case of physical parameters, treatment (T10) Whole wheat flour (85.00 %) + tulsi leave powder (7.50 %) + with lemongrass leaves powder (7.50 %), the diameter (6.34 cm), thickness (0.79 cm), and weight (4.03 cm) were reported as significant and maximum, respectively.  **Conclusion:** According to the above study, adding tulsi leaf powder (7.50%) and lemongrass leaf powder (7.50%) to treatment T10 boosts the product's physical and nutritional value. |

*Keywords:* Lemongrass, tulsi, flour, biscuits and lab

1. INTRODUCTION

Provide a factual background, clearly defined problem, proposed solution, a brief literature survey and the scope and justification of the work done.] With increasing urbanization in India, the demand for processed food is also increasing rapidly. Among the processed foods, bakery products, particularly biscuits command wide popularity in rural as well as urban areas among all the age groups (Agarwal, 1990). This is due to longer shelf life, even if prepared in local bakeries, easy marketing, low cost, varied taste and texture. Biscuit is a small thin crispy cake made from unleavened dough. Biscuits have been suggested as a better use of composite flour than bread due to their ready to eat form, wide consumption, relatively long shelf life, and good eating quality (Okpala and Chinyelu, 2011). It may be regarded as a form of confectionery dried to very low moisture content (Okaka, 1997). The dependence on the use of wheat flour is a major constraint in biscuit production. Wheat (*Triticum aestivum* L.) is a cereal grain grown all over the world for its highly nutritious and useful gain. It is one of the top three most produced crops in the world, along with corn and rice. According to Okaka, (2005) only wheat contains substantial amount of gliadin and glutenin (special protein) which when kneaded with water give gluten, the elastic material important in yeast or aerated baked goods. In terms of total production tonnages used for food, it is currently second to rice as the main human food crop (Curtis *et al.,* 2002). Much of the carbohydrate fraction of wheat is starch. Wheat starch is an important commercial product of wheat, but second in economic value to wheat gluten. The principal parts of wheat flour are gluten and starch.

Biscuits are ideal for their nutritive value, palatability, compactness and convenience (Kulkarni *et al.,* 1997). Having low moisture content than cakes and bread, biscuits are generally safer from microbiological spoilage and have long shelf-life (Akubor, 2003). The present investigation was planned to develop a product with high fiber content and low caloric value. Biscuits have always been one of the most popular and appealing food products due to its superior nutritional, sensorial and textural characteristics, ready to eat convenience as well as cost competitiveness (Pratima and Yadava, 2000). Nowadays, emphasis is on healthy Biscuits with low glycemic index, more protein and will increase the dietary fiber intake, high resistant starch and decrease in calorie and carbohydrates of baked goods. Herbal Biscuits are made by incorporation of tulshi, lemongrass and moringa leaves in a mixture of whole wheat flour, wheat flours, sugar powder, vegetable oil (soybean), dalda, baking powder, skim milk powder, egg white, iodized salt, and other general ingredients.

Lemongrass oil is produced in small quantities across the world, with an annual production of estimated 1000 tonnes from a 16000 ha area (Gawali and Meshram, 2019). Lemongrass is essential among aromatic plants in the international market because its oil contents are about 75-80 percent citral. The lemongrass has a very wide demand in nutritional, medicinal and flavoring industry. But it is not stored as fresh for long time at ambient condition because it rotten after long periods. Hence, lemongrass powder is preferred and it has huge demand in the world market. Traditionally, lemongrass powder is prepared by grinding the dried leaves. Lemongrass is a perennial, multi-cut aromatic grass cultivated in tropical and subtropical regions in India. Lemongrass oil is a good source of citral used in perfumery, pharmaceutical, cosmetics and aromatherapy industries and the production of vitamin A (Sharma *et al.,* 2022).

Functional foods are termed as “food for specified health use”. The term basically originated from Chinese saying “Food and medicine are isogenic”. Functional foods are on main focus due to their health benefits and nontoxic behavior. In addition to their nutritional benefits, functional foods found effective against some health problems due to their antimicrobial, anti-cancerous and anti-inflammatory properties. Large number of functional food products is being developed and have found prominent place in present market such as functional drinks, functional bakery and dairy products. One of the important her b is lemongrass (*Cymbopogon citratus*) with more than 500 species, wide growing capabilities and unique functional properties, catching usefulness in many of the daily life food commodities. All forms of lemongrass such as leave, stalk, oil, flavor used for having best minerals and antioxidants. A lot of work needed to explore the functional properties of this herb by analyzing in different conditions and utilizing in various food items for human consumption such as functional drinks at community level. The review designed to concise the nutrional and functional importance of lemongrass in addition to functional foods formulated foods from various sources (Ranjah *et al.,* 2018).

Bakery products are the important source of nutrients. Different types of bakery products include bread, biscuits, pastries, cakes, buns, rusk, etc. Biscuits are the lowest cost processed food. The present research work is focused on production of herbal biscuit using tulsi and lemongrass leaves as herbal biscuit in which tulsi helpful for boosts immunity, heals infections, purifies the blood, cures insects bites, lowers blood pressure, treats respiratory disorders, maintains blood sugar level, and lemongrass relieving anxiety, lowering cholesterol, preventing infection, boosting oral health, relieving pain, boosting red blood cell levels and relieving bloating etc. Further, it is an attempt to formulate herbal biscuit with added health benefit and value addition. The overview of literature reveals that knowledge of technology with regard to production, packaging and preservation of herbal biscuit is completely inadequate. Overall, incorporating tulsi and lemongrass in biscuit provides various benefits, including improved nutrition, dietary diversity, allergen-friendliness, sustainability, and enhanced taste. It offers a healthier and more inclusive option for individuals with specific dietary needs while adding a unique twist to the traditional snack.

2. material and methods

**2.1 Study Place**

The experimental work was conducted in the Department of Processing and Food Engineering Laboratory, Vaugh Institute of Agricultural Engineering and Technology, Sam Higginbottom University of Agriculture Technology & Sciences, Prayagraj.

**Table 1.** Experimental plan related wheat flour, tulsi and lemongrass leaves powder incorporated biscuit

|  |  |  |  |
| --- | --- | --- | --- |
| Sr. No. | Parameter | Level | Description |
| 1. | Product | 1 | Biscuit |
| 2. | Ingredients | 4 | Sugar powder, Amul Butter, Baking soda and Amul milk powder |
| 3. | Treatments | 10 |  |
| 4. | Storage conditions | 1 | Ambient temperature |
| 5. | Packaging material | 1 | Flexible pouch (Airtight Pouch) |
| 6. | Analysis of output (Biscuit) |  | Physico-Chemical analysis - diameter, thickness, weight, spread ratio, moisture, protein, ash, fat, crude fiber and carbohydrate |
| 7. | Statistical Analysis | 1 | Completely randomized design (CRD) |
| 8. | Replications | 3 | R-I, R-II, R-III |

**2.2 Physical** **properties**

Physical propertiesof tulsi and lemongrass leaves powder biscuit done on the basis of diameter, weight, thickness and spread ratio.

*Diameter*: Diameter of biscuit was determined by placing four biscuit edge to edge. The total diameter was measured in centimeter with the help of vernier callipers. The biscuit were rotated at an angle of 900 for duplicate readings. This process was repeated by thrice to get an average value and results were reported in centimeter.

*Thickness*: The thickness of the biscuit was determined by placing four biscuit stacking on one another. The thickness was measured in centimeter with the

**Table 2.** Formulation table of wheat flour, tulsi and lemongrass leaves powder for biscuit

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sr. No. | Whole wheat flour (g) | Tulsi leave powder (g) | Lemongrass leaves powder (g) | Treatment total (g) | Row material used for all treatment | | | | Total (Treatment +Raw material) (g) |
| Sugar powder (gm) | Amul Butter (g) | Baking Soda (g) | Amul milk powder(g) |
| T1 | 100.00 | 0.00 | 0.00 | 100.00 | 30.00 | 40.00 | 1.00 | 18.00 | 189.00 |
| T2 | 97.50 | 2.50 | 0.00 | 100.00 | 30.00 | 40.00 | 1.00 | 18.00 | 189.00 |
| T3 | 97.50 | 0.00 | 2.50 | 100.00 | 30.00 | 40.00 | 1.00 | 18.00 | 189.00 |
| T4 | 95.00 | 2.50 | 2.50 | 100.00 | 30.00 | 40.00 | 1.00 | 18.00 | 189.00 |
| T5 | 95.00 | 5.00 | 0.00 | 100.00 | 30.00 | 40.00 | 1.00 | 18.00 | 189.00 |
| T6 | 95.00 | 0.00 | 5.00 | 100.00 | 30.00 | 40.00 | 1.00 | 18.00 | 189.00 |
| T7 | 90.00 | 5.00 | 5.00 | 100.00 | 30.00 | 40.00 | 1.00 | 18.00 | 189.00 |
| T8 | 92.50 | 7.50 | 0.00 | 100.00 | 30.00 | 40.00 | 1.00 | 18.00 | 189.00 |
| T9 | 92.50 | 0.00 | 7.50 | 100.00 | 30.00 | 40.00 | 1.00 | 18.00 | 189.00 |
| T10 | 85.00 | 7.50 | 7.50 | 100.00 | 30.00 | 40.00 | 1.00 | 18.00 | 189.00 |

help of vernier caliper. This process was repeated thrice to get an average value and results were reported in centimeter.

*Weight:* Five pieces of control and sensory accepted biscuits were weight by using weighing balance and average weight of both samples were recorded (Jauharah *et al*., 2014).

*Spread ratio:* Spread ratio was calculated as diameter (length) to thickness ratio.

Spread ratio = diameter/ thickness

*Determination of moisture content of biscuit:*

The moisture content in the sample was estimated according to the method of AOAC (1990). *Procedure:* The instrument used for moisture determination was hot air oven. About 5 g of sample was weighed in the moisture dish; previously air dried in the oven and weighed, then placed the dish in the oven maintained at the 120 °C for 1 h. It was cooled in the desiccator and weighed. The process of drying was repeated, cooling and weighing at 30 minutes intervals until the difference between the two consecutive weighing was less than 1 mg recorded as the lowest weight. Moisture content was calculated using the formula.

Moisture content (%) : (w₁-w₂)/(w1-w) ×100

Where, w: weight, in g of the dish with the empty dish. w₁: weight in g of the dish with the material before drying. w₂ : weight in g of the dish with material after drying.

*Determination of protein content of biscuit:*

The micro kjeldahl method described by AOAC (1984) was used to determine the protein content. Two g of each of the samples were mixed with 10ml of concentrated H2SO4 in a heating tube. 2-3g of catalyst mixture was added to the tube and the mixture was heated inside a fume cupboard. The digest was transferred into distilled water. 10 ml portion of the digest mixed with equal volume of 40% NaOH solution was taken and poured into a micro kjeldahl distillation apparatus. The mixture was distilled, and the distillate collected into 2% boric acid solution containing Bromocresol green and methyl red indicator in ratio of 1:5. A total of 50 ml distillate was collected and titrated. The sample was duplicated, and the average value was taken. The Nitrogen content was calculated and multiplied with 6.25 to obtain the protein content. Protein content was determined using formula:

Nitrogen (%): (100×N×14×VF)T/(100×Va)

Protein (%) = Nitrogen (%) × 6.

Where, N: Normality of the titrate (0.1N), VF: Total volume of the digest= 100ml

T: Titre Value, VA: Aliquot Volume distilled

*Determination of fat content of biscuit*: The fat content was determined by the ether extraction using Soxhlet’s apparatus. Reagent Petroleum ether having a boiling point of 40-60 °C was used. Five gram of ground de moisturized sample was weighed accurately in thimble and defatted with petroleum ether in Soxhlet’s apparatus for 6-8 hrs at 60 °C. The resultant ether extract was evaporated and the lipid content was calculated (AOAC, 1984) as given in equation 3.5.

Fat (%): (w2-w1)/w3 ×100

Where, w1: weight of the empty extraction flask. w2: weight of the flask and oil extracted. w3 : weight of the sample

*Determination of ash content of biscuit*:

The ash content in the sample was estimated according to AOAC (1990). *Procedure:* About 5 g of the powder sample was accurately weight into a pre-weighed silica crucible. It was then carbonized in silica crucible on burner followed by heating at about 600 °C for 6 hrs. In the muffle furnace to get complete white it was cooled in the furnace. Then the crucible was transfer to desiccators and weighed as possible to prevent moisture absorption. Ash content was determined using Formula,

Ash content (%): (w₂-w₁)/w×100

Where,

w₂: Final weight of dish + Ash. w₁: weight of dish. w: Weight of sample

*Statistical analysis:*

Analysis of variance (ANOVA) was used in all the analysis for detection of significant differences (p<0.05) among samples. The data was statistically analyzed by using complete randomized design (CRD) with seven treatments; the significance of study was tested at 5 per cent level (Panse and Sukhatme, 1967).

3. results and discussion

**3.1 Physical properties**

Based on the diameter (6.34 cm) physical property analysis of the biscuit, the treatment (T10) using whole wheat flour (85.00%) plus tulsi leaves powder (7.50%) and lemongrass leaves powder (7.50%) had a significantly greater diameter physical property result than the other treatments (Table-3). This increase in the diameter of biscuit is due to increase in fiber contents of biscuit with dietary fiber content in tulsi and lemongrass leaves powder (Kulthe *et al.,* 2018). The significant increase in diameter decrease in thickness with increase in tulsi and lemongrass leaves powder could be due to the reduction in gluten content (elasticity) with increase in tulsi and lemongrass leaves powder. Too little elasticity may cause dough to flow after molding, resulting in thin biscuit with larger diameter (Gernah and Anyam, 2014). The treatment (T10) applied whole wheat flour (85.00%) plus tulsi leaves powder (7.50%) and lemongrass leaves powder (7.50%) showed a significantly higher thickness (0.79 cm) physical property result than the other treatments of the biscuit. The height or thickness of the spreadable layer and the biscuit breaking strength are related. The ability of a biscuit to withstand stress or an impact load decreases as its size becomes thinner (Oke *et al.,* 2022). Dietary fiber of the biscuit formulations also affected the thickness development during cooking (Mridula *et al.,* 2007). Too much elasticity (gluten) in the dough will spring back to give thicker biscuit with smaller diameter (Gernah and Anyam, 2014). The greater water holding capacity of fibers may be the reason of this (Ayoub *et al.,* 2022). According to the weight (4.03 g) physical property analysis of the biscuit, treatment (T10) using whole wheat flour (85.00%) plus tulsi leaves powder (7.50%) and lemongrass leaves powder (7.50%) produced a significantly higher weight physical property result than the other treatments. The increase in the weight of the biscuit could be as a result of imbibitions of water due to the higher water absorption/retention capacity of the tulsi and lemongrass leaves powder, as observed from the gradual increase in the moisture content of the biscuit from the blends Gernah and Anyam, (2014). Due to the fibrous material found in the wheat flour, tulsi and lemongrass leaves powder, the weight of the biscuit may have risen due to the dough’s higher water demand (Ayoub *et al.,* 2022).

According to the spread ratio (9.06) of the biscuit, treatment (T6) using whole wheat flour (95.00%) plus tulsi leaves powder (5.00%) produced a non significant and maximum spread ratio physical property result than the other treatments.

**3.2 Chemical properties**

After the analytical study it was seen that the chemical analysis of moisture, the treatment (T10) Whole wheat flour (85.00%) + tulsi leave powder (7.50%) + with lemongrass leaves powder (7.50%) had the non significant and maximum moisture content (4.86 %) when compared to other treatments (Table-4). The result of tulsi and lemongrass leaves powder prepared biscuit significantly higher data of protein content (7.82 g/100g) noticed under the treatment (T10) Whole wheat flour (85.00 %) + tulsi leave powder (7.50 %) + with lemongrass leaves powder (7.50 %) compared to other treatments. The high protein contribution from tulsi, and lemongrass as compared to other treatments used in the biscuit preparation might be the reason for high protein content of T10 biscuit. It might be due to after incorporating of tulsi and lemongrass leaves powder, the nutritive value was improved Alam *et al.,* 2013). Owing to higher protein content of these two plant sources it could be ­assumed that addition of tulsi and lemongrass leaves powder in biscuit have a greater potential in overcoming protein calorie malnutrition for the people (Farzana *et al.,* 2017). The outcome was comparable to that attained by (Aswini, 2022; Singh, 2004; Alam *et al.,* 2014; Shukla *et al.,* 2016; Vidhani *et al.,* 2016;Veer *et al.,* 2019; Gaikwad, 2021; Kumari *et al.,* 2022; Jariyah, 2018).

Comparing the treatment (T10) of whole wheat flour (85.00%) + tulsi leave powder (7.50%) + with lemongrass leaves powder (7.50%) to other treatments, the significantly higher fat content of the biscuit made with tulsi and lemongrass leaves powder was reported to be (11.81 g/100g). Tulsi, and lemongrass contained high fat compared to other treatment resulting in higher fat content of T10 biscuit. It might due to many active components of the Tulsi, leaves are the source of an essential oil i.e eugenol and ursolic acid. The main chemical constituents of lemongrass essential oil are: Myrcene, Citral, Citronellal, Geranyl Acetate, Nerol, Geraniol, and Limonene (Anonymous, 2023). The increase in fat content in the present study may be explained as tulsi and lemongrass leaves powder are globally considered as the various edible oil source, containing a higher percentage of fat than wheat flour (Farzana and Mohajan, 2015). The outcome was comparable to that attained by (Husain *et al.,* 2015 a; Husain *et al.,* 2016).

After the analytical study it was seen that the treatment (T10) Whole wheat flour (85.00%) + tulsi leave powder (7.50%) + with lemongrass leaves powder (7.50%) significantly higher effect on the ash (3.33 g/100 g) of biscuit when compared to other treatments. The high mineral content of tulsi, and lemongrass might have resulted in high ash content in T10 of biscuit as compared to other biscuit. It might due to the presence of tulsi and lemongrass leaves powder in the biscuit preparation as tulsi and lemongrass leaves are good source of minerals, supported by other studies (Mohajan *et al.,* 2018; Ayo *et al.,* 2014; Sengev & Gernah, 2013). Ash content in a food substance indicates inorganic remains after the organic matter has been burnt away. Ash content of a food material could be used as an index of mineral constituent of the food (Priya and Lalitha, 2016).

4. Conclusion

Current trends and shifting customer preferences point to an important possibility for innovation in the creation of new value-added herbal and plant-based baking goods. As herbal products are becoming more popular on the global market due to their strong therapeutic potential, lack of side effects, and presence of health-beneficial active pharmacological ingredients, the food sector is preparing to deliver natural medicines that are safe and effective. People of all ages are drawn to biscuits because they are a filling bakery dessert that nourishes while it refreshes. According to the above study, adding tulsi leaf powder (7.50%) and lemongrass leaf powder (7.50%) to treatment T10 boosts the product's physical and nutritional value.

References

AACC. (2000). Official methods of analysis of AACC International, American Association of Cereal Chemists, Washington DC.

Agarwal, S. R. (1990). Prospects for small scale biscuit industry in the nineties. *Indian Food Industry* 9: 19-21.

Akubor, P. (2003). Functional properties and performance of cowpea/plantain/wheat flour blends in biscuits. *Springer* 58(3): 1-8.

Alam, M. J., Huq, A. K. O., Prodhan, U. K., Talukder, M. U. (2013). Development of fiber enriched herbal biscuits by incorporating tulsi leaves on wheat flour: A preliminary study on sensory evaluation and chemical composition. *Research & Reviews: Journal of Herbal Science.* 2(2):1-5.

Alam, Md. Ariful., Alam, Md. Jahangir., Hakim, Md. Abdul., Huq, A. K. Obidul., Moktadir, S. M. G. (2014). Development of fiber enriched herbal biscuits: A preliminary study on sensory evaluation and chemical composition. *International Journal of Nutrition and Food Sciences* 3(4): 246-250 doi: 10.11648/j.ijnfs.20140304.13.

Anonymous. (2023). Lemongrass essential oil: benefits and uses for hair, skin, and joints. <https://www.newdirectionsaromatics.com/blog/products/all-about-lemongrass-oil.html>.

AOAC. 1984. Methods of Analysis, 10th Ed. Int. Assoc. Official Analytical Chemists: Washington, DC.

AOAC. (1990). Methods of Analysis, 16th Ed. Int. Assoc. Official Analytical Chemists: Washington, DC.

Aswini, Potharaju. (2022). Development of value-added biscuits by incorporating finger millet (*Eleusine coracana*) and colocasia leaves powder (*Colocasia antiquorum*). ‘M.Sc. Thesis’. Acharya N. G. Ranga Agricultural University. Guntur, Andhra Pradesh. <https://krishikosh.egranth.ac.in/handle/1/5810186605>.

Ayo, J. A., Ayo, V. A., Popoola, C., Omosebi, M. & Joseph, L. (2014). Production & evaluation of malted soybean-acha composite flour bread & biscuit. *African Journal of Food Science & Technology* 5(1): 21-28.

Ayoub, W. S., Zahoor, I., Dar, A. H., Anjum, N., Pandiselvam, R., Farooq, S., Rusu, A. V., Rocha, J. M., Trif, M. and Jeevarathinam, G. (2022). Effect of incorporation of wheat bran, rice bran and banana peel powder on the mesostructure and physicochemical characteristics of biscuits. 9:1-12. *Frontiers in Nutrition*. <https://doi.org/10.3389/fnut.2022.1016717>.

Curtis, B. C., S. Rajaram, and H. G. Macpherson. (2002). Bread wheat: improvement and production. Food and Agriculture Organisation of the United Nations, Rome, Italy. Pp. 221-222.

Farzana, T., Mohajan, S., Saha, T., Hossain, M. N., Haque, M. Z. (2017). Formulation and nutritional evaluation of a healthy vegetable soup powder supplemented with soy flour, mushroom, and moringa leaves. *Food Science & Nutrition* 1-10. DOI: 10.1002/fsn3.476.

Farzana, [Tasnim](https://pubmed.ncbi.nlm.nih.gov/?term=Farzana%20T%5BAuthor%5D)  and Mohajan, [Suman. (2015).](https://pubmed.ncbi.nlm.nih.gov/?term=Mohajan%20S%5BAuthor%5D) Effect of incorporation of soy flour to wheat flour on nutritional and sensory quality of biscuits fortified with mushroom. *Food Science & Nutrition* 3(5): 363-369.

Gaikwad, Vanita Gajanan. (2021). Preparation of value added products cookies and biscuits from garden cress seed. ‘M.Sc. Thesis’. Mahatma Phule Krishi Vidyapeeth. Rahuri, Maharashtra.<https://krishikosh.egranth.ac.in/items/c58e4113-186c-4f3f-a4f3-8fa3f88fdaba/full>.

Gawali, A. S. and Meshram, N. A. (2019). Scientifically cultivation of lemon grass -a potential aromatic crop. *Plant Archives* 19(2): 2860-2864.

Gernah, D. I and Anyam, K. (2014). Production and quality assessment of protein-rich biscuits from blends of wheat and defatted sesame flours. *International Journal of Food Processing Technology* 1: 27-31.

Husain, S. A., David, J., Ibrahim, M., Ali, M. N., Chandra, R and Srivastava, P. (2015 a). Studies on chemical properties and nutritive value of dairy dessert (Sandesh) Incorporated with ashwagandha (*Withania somnifera*) and tulsi (*Ocimum sanctum*). *Journal of Pharma Research* 4(8): 281-283.

Husain, Saiyyad. Alamdar. (2016). Manufacturing of herbal sandesh by incorporation of ashwagandha (*Withania somnifera*) and tulsi (*Ocimum sanctum*). ‘Ph.D Thesis’. Sam Higginbottom University of Agriculture, Technology And Sciences. Uttar Pradesh, India.<https://krishikosh.egranth.ac.in/assets/pdfjs/web/viewer.html?file=https%3A%2F%2Fkrishikosh.egranth.ac.in%2Fserver%2Fapi%2Fcore%2Fbitstreams%2Ff2b89afe-7ffe-4c21-b496-16dc7c1e1078%2Fcontent>.

Jariyah, Y, E., Sarofa, U. and Sopade, P. A. (2018). Effect of partial replacement of wheat flour with various mangrove fruit flours and different emulsifiers on physicochemical properties of biscuits. *Indonesian Journal of Agricultural Research* 01(02): 152-161.

Jauharah, A., Rosli, W. and Robert, S. (2014). Physicochemical and sensorial evaluation of biscuit and muffin incorporated with young corn powder. *Sains Malaysiana* 43: 45-52.

Kulkarni, S. D. (1997). Roasted soybean in cookies. Influence on product quality. *Journal of Food Science and Technology* 34: 503-505.

Kulthe, A. A. (2018). Nutritional and sensory characteristic of biscuits prepared from pearl millet flour. *The Pharma Innovation Journal* 7(4): 908-913.

Kumari, Nisha, Bala, K. Lakshmi., Kumar, Avanish and Sinha, Deepak Kumar. (2022). Response surface methodology as an optimizing strategy in herbal latte mix formulation*. The Pharma Innovation Journal* 11(3): 2061-2072.

Livesey, G. (1995). Metabolizable energy of macro nutrients. *The American Journal of Clinical Nutrition* 62: 1135-1142.

Mohajan, Suman., Orchy, T. N. Farzana, Tasnim. (2018). Effect of incorporation of soy flour on functional, nutritional, and sensory properties of mushroom–moringa-supplemented healthy soup. *Food Science & Nutrition* 6: 549–556 DOI: 10.1002/fsn3.594.

Mridula, D., Gupta, R. K and Ramarathinam, M. (2007). Effect of incorporation of sorghum flour to wheat flour on quality of biscuits fortified with defatted soy flour. *American Journal of Food Technology* 2(5) 428-434. DOI:10.3923/ajft.2007.428.434.

Okaka, J. C. (1997). *Cereal and legumes storage and processing tech*. Data and micro system Publication, Enugu. pp 133.

Okaka, J. C. (2005). Handling, storage and processing of plant food. OCJANCO academic publishers, Enugu, Nigeria. pp. 250-270.

Oke, M. O., Hussein, J. B., Ijale, R. A. and Ojo, S. E. (2022). Development and quality assessment of biscuits made from mixture of wheat, soybean, and sorghum flour. Sciendo. *Acta Universitatis Cibiniensis Series E: Food Technology* 26(2): 261-270. 10.2478/aucft-2022-0021.

Okpala, L. C., and V. A. Chinyelu. (2011). Physicochemical,Nutritional and Organoleptic evaluation of cookies frompigeon pea (*Cajanus cajan*) and cocoyam (*Xanthosoma Sp*) flour blends. *African Journal of Food, Agriculture, Nutrition and Development* 11:1–13.

Panse, V. G. and Sukhatme, P. V. 1967. Statistical methods for agricultural workers. 2nd Ed.. *Indian Council of Agricultural Research*, New Delhi: 381.

Pratima, A and Yadava, M. C. (2000). Effect of incorporation of liquid dairy by products on chemical characteristics of soyfortified biscuits. *Journal of Food Science and Technology* 37(2): 158-161.

Priya and Lalitha. (2016). Physical, chemical and microbial properties of cookies developed using coconut products. *International Journal of Recent Scientific Research* 7(3): 9670-9674.

Ranjah, M. A., Waseem, M., Taj, F., Ashraf, I. (2018). Lemongrass (*cymbopogon citratus*): a valuable ingredient for functional foods. *International Journal of Food and Allied Sciences* 4(2): 11-19.

Sengev, A. I., Abu, J. O and Gernah, D. I. (2013). Effect of Moringa oleifera leaves powder supplementation on some quality characteristics of wheat bread. *Food & Nutrition Sciences* 4(3): 270-275. https://doi. org/10.4236/fns.2013.43036.

Sharma, R. S., Kumar, Yogesh., Bhise, R. N., Choudhri, H. P. S., Verma, D. K., Srivastava R. K and Kumar, S. (2022). Economics of lemongrass cultivation in Jharkhand State. *Economic Affairs* 67 (09): 01-06.

Shukla, R. N., Mishra, Atul anand and Gautam. A. K. (2016). Development of protein enriched biscuit fortified with green gram flour. *Food Science Research Journal* 112-118 DOI: 10.15740/has/fsrj/7.1/112-118.

Singh, Suruchi. (2004). Evaluation of wheat varieties and development of high fiber biscuits. ‘M.Sc. Thesis’. Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana. <http://krishikosh.egranth.ac.in/handle/1/5810030526>.

Veer, S. J., Pawase, P. A and Gadhave, R. K. (2019). Studies on textural profile, nutritional profile and microbial studies of ashwagandha root powder added ice cream. *International Journal of Food Science and Nutrition* 4(6); 107-110.

Vidhani, S. I., Vyas, Vijay. G., Parmar, Heena. J., Bhalani, Viren, M., Hassan, Mohammad. M., Gaber, Ahmed., Golakiya, Baljibhai. A. (2016). Evaluation of some chemical composition, minerals fatty acid profiles, antioxidant and antimicrobial activities of tulsi (*Ocimum sanctum*) from India. *American Journal of Food Science and Technology* 4(2): 52-57.

Yadav, G., David, J., Thakur, S. N., Shukla, S., Kumari, A., Yadav, V and Shalini. (2020). Evaluation of sensory attributes in different levels of Tapioca in pro-biotic Ice cream. *The Pharma Innovation Journal* 9(1): 404-407.